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DISC WHEEL AND MANUFACTURING METHOD FOR DISC WHEEL
[Disukuhoiiru oyobi disukuhoiiru no seizou houhou]

Hiroshi Manabe

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INVENTOR	(72):	MANABE, HIROSHI
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[Claims] /2*

[Claim 1] A disc wheel manufacturing method characterized in that it comprises a process for press-forming a plate-shaped expandable material into a cylinder with a bottom and a process for providing the cylinder part of the expandable material, which has been formed into a cylinder with a bottom in the above-mentioned process, with different diameters in the axial direction by means of spinning.

[Claim 2] A disc wheel formed from an integrated expandable material, characterized in that it comprises a disc-shaped disc part and a rim part in which one axial end is integrally continuous to the outer rim of the disc part and which has a cylindrical shape that decreases in diameter because of pressures applied to the outer periphery except for its both axial ends.

[Detailed Description of the Invention]

[0001] [Field of the Invention]

The present invention relates to disc wheels and a manufacturing method for disc wheels.

[0002] [Related Art]

Figure 5 shows a method for manufacturing conventional automobile disc wheels in which multiple components do not need to be connected by means of welding or the like (See JP H7-290179).

[0003] According to this manufacturing method, a column-shaped workpiece (billet) composed of an expandable metal is disposed between an upper mold [110] and a lower mold [112], and the upper mold [110] and the lower mold [112] are made to approach each other while rotating in

* Number in the margin indicates pagination in the foreign text.

synchronization. The metal which makes up the workpiece protrudes from between the upper mold [110] and the lower mold [112], and this protruding metal is drawn vertically by means of a pressure roller [114] to form parts, [118] and [120], which correspond to rims and also to finish making a disc [116] between the upper mold [110] and the lower mold [112]. Furthermore, these parts, [118] and [120], corresponding to rims are formed into rims by means of rolling. At this time, the parts corresponding to rims are made to have almost triangular cross-sections that increase in thickness toward the front ends by gradually changing the interval between the upper mold [110] or the lower mold [112] and the pressure roller [114].

[0004] However, according to this disc wheel manufacturing method, strong compressive forces are necessary to sandwich and crush a workpiece between the upper mold [110] and the lower mold [112]. Also, the formation of the parts, [118] and [120], corresponding to rims requires that the disc[116] stick out from between the upper mold [110] and the lower mold [112] and also requires that they be drawn by the pressure roller [114]. As a result, the manufacturing equipment becomes large and expensive.

[0005] Figure 6 shows a manufacturing method of automobile disc wheels different from the manufacturing method mentioned earlier (See JP H4-11701).

[0006] According to this manufacturing method, a circular rolled material [130] comprising a light metal as the raw material (See Figs. 6(A) and 6(B)) is provided with annular projections [132], and these projections [132] and their vicinities are made to be the disc part. As shown in Fig. 6(D), a bolt mounting hole [136] is provided at an appropriate

location of this disc part. A cleavage part [138] is formed on the rim of the rolled material [130] by pushing open the outer periphery of the rolled material toward the thickness center of the rolled material [130] in the circumferential direction, and this cleavage part [138] is opened to the left and right as illustrated in Fig. 6(F). Then, this cleavage part [138] is subjected to spinning to form a rim part [140] having a predetermined shape. Lastly, a valve mounting hole [142] is made on one end of the rim part [140] as illustrated in Fig. 6(G).

[0007] According to this manufacturing method, the rim part [140] is formed by cutting open the rolled material [130]. Therefore, if the thickness of the right side of the rim part [140] is made to be [T(R1)], the thickness of the right side of the rim part [140] is made to be [T(R2)], and the thickness of the disc part is [T(D)], the following relationship will be true.

$$T(R1)+T(R2)\leq T(D)$$

Accordingly, the thickness [T(D)] of the disc part will be thicker than the thickness (T(R1)+T(R2)) of the rim part [140]. Therefore, if the thickness necessary for providing the rim part [140] with predetermined strength exceeds the thickness for providing the disc part with predetermined strength, the thickness of the disc part will be unnecessarily large. For example, even if 8mm would be sufficient for [T(D)], [T(D)] will need to be at least 10mm if [T(R1)] and [T(R2)] need to be 5mm. In other words, the disc part will be 2mm too thick, and the weight is increased as a result.

[0008] [Problems that the Invention is to Solve]

In light of this situation, the aim of the present invention is to provide light-weight disc wheels that are easy to form and to also provide a method for manufacturing such disc wheels.

[0009] [Means for Solving the Problems]

The invention according to Claim 1 is characterized in that it comprises a process in which a plate-shaped expandable material is press-formed into a cylinder with a bottom and a process in which the cylinder part of the expandable material that was formed into a cylinder with a bottom in the above-mentioned process is made to have different diameters along the axial direction by means of spinning.

[0010] As a result, the bottom part of the plate material having been formed into a cylinder with a bottom will be the disc part of a disc wheel, while the cylinder part will be the rim part of the disc wheel.

[0011] Since a plate-shaped expandable material is formed into a cylinder with a bottom by means of press forming, only a small compression force is necessary for the press forming instead of the large compression force necessary for the conventional case in which a workpiece (billet) is sandwiched and crushed by molds.

[0012] Moreover, since the cylinder part is formed from a plate-shaped expandable material by means of press forming, the thickness of the cylinder part will be uniform. Also, the cylinder part can be made to have various diameters with ease by means of spinning.

[0013] In addition, in comparison to the conventional case in which the rim part is formed by the disc being cut open, the rim part can be provided with predetermined strength even if the disc part is thin, /3

and the weight of the disc wheel can be reduced as a result. Furthermore, it is possible to make the cylinder part to be generally or partially thinner in the axial direction than the pre-spinning thickness.

[0014] Moreover, since this manufacturing method enables the manufacture of a disc wheel from an integrated expandable material, a welding process and the like necessary for forming a disc wheel from multiple components is unnecessary, and the productivity increases as a result.

[0015] The invention according to Claim 2 is an integrated disc wheel formed from an expandable material, and is characterized in that it comprises a disc-shaped disc part and a rim part in which one axial end is integrally continuous to the outer rim of the disc part and which has a cylindrical shape that decreases in diameter because of pressures applied to the outer periphery except for its axial ends.

[0016] Since the rim part and the disc part are integrally formed from an integrated expandable material, the process for welding and the like is unnecessary and the productivity is improved in comparison to a disc wheel formed from multiple components. Moreover, since the thickness of the rim part can be made approximately the same as the thickness of the disc part, the rim part can be provided with predetermined strength even if the disc part is thin in comparison to the conventional disc wheel in which the rim part is formed by the disc being cut open. For this reason, the weight of the disc wheel can be reduced.

[0017] As the method for creating a cylindrical rim part that is

integrally continuous from the outer rim of the disc part from an expandable material, press forming, for example, can be utilized. For this reason, a large compression force, which is necessary for forming the conventional disc wheel by sandwiching and crushing a billet, is not necessary, and only a small compression force is necessary for the press forming.

[0018] As the method for reducing the diameter of the rim part by applying pressure to it, spinning, for example, can be utilized. This makes it easy to reduce the diameter of the rim part.

[0019] [Embodiment of the Invention]

Figure 1 shows a cross-sectional drawing of a disc wheel [10] that relates to one embodiment of the invention.

[0020] This disc wheel [10] comprises a disc part [12] obtained by forming an expandable material (e.g., aluminum) into an approximate disc shape and an approximately cylindrical rim part [14] that has been made integrally continuous from the outer rim of the disc part [12].

[0021] The disc part [12] comprises a flat disc-shaped inner circle part [16], a tapered part [18] which is bent diagonally in the direction (toward the right in Figure 1) opposite from the direction of the formation of the rim part [14], and an outer ring part [20] which extends outward in the diameter direction from the outer rim of the tapered part [18]. The inner circle part [16], tapered part [18], and outer ring part [20] have approximately the same thickness. Since the disc part [12] has the above-mentioned shape, the inner circle part [16] is shifted from the center [C] of the rim (the axial center line of the rim part [14]) by a distance [L].

[0022] There is a hub hole [22] of a predetermined diameter at the center of the inner circle part [16]. The axle (not shown) of the vehicle body is, as necessary, inserted from the left side (as in Fig. 1) of the hub hole [22] to position the disc wheel [10] against the axle in the diameter direction (henceforth, the side (the left side in Fig. 1) from which the axle is inserted will be referred to as the "in side" and the opposite side (the right side in Fig. 1) will be referred to as the "out side" by taking into account the positional relationship between the vehicle body and the disc wheel [10]). On the outer side of the hub hole [22] in terms of the diameter direction, multiple bolt holes [24] are formed in the circumferential direction at predetermined intervals. Bolts (not shown) protruding from the axle are inserted through the bolt holes [24] from the in side, and nuts (not shown) are screwed in from the front open ends of the bolts, consequently attaching the disc wheel [10] to the axle.

[0023] As shown in detail in Fig. 2, the outer rim of the outer ring part [20] of the disc part [12] is folded back toward the inner side in terms of the diameter to form a flange [26] which makes up part of the rim part [14]. This flange [26] prevents a tire (not shown) attached to the disc wheel [10] from being displaced toward the out side. Moreover, the flange [26] is overlapped with the outer ring part [20] of the disc part [12] and strengthens the outer ring part [20].

[0024] From the inner rim of the flange [26], there is the formation of an approximately cylindrical out-side cylindrical part [28] having a diameter that becomes smaller very gradually from the out side to the

in side. Furthermore, from the in-side end of the out-side cylindrical part [28], there is the formation of a step part [30] having a diameter that radically becomes smaller toward the central axis [J1] of the disc wheel [10]. Moreover, from the in-side end of the step part [30], there is the formation of a reduced-diameter part [32] having constant diameter and thickness. The out-side cylindrical part [28], step part [30], and reduced-diameter part [32] have approximately the same thickness [T(A)] as the disc part [12].

[0025] From the in-side end of the reduced-diameter part [32], there is the formation of a tapered part [34] having a diameter that gradually increases from the out side to the in side and a thickness that decreases gradually. The thickness of the axial center of the tapered part [34] is denoted as [T(B)], and the thickness of its in-side end is denoted as [T(C)]. From the in-side end of the tapered part [34], there is the formation of an approximately cylindrical in-side cylindrical part [36] having a diameter that gradually increases to be larger than that of the tapered part [34] and a thickness [T(C)] that remains constant.

[0026] As is clear from Fig. 2, the relationship among the thickness [T(A)] of the reduced-diameter part [32], the thickness [T(B)] of the axial center of the tapered part [34], and the thickness [T(C)] of the in-side cylindrical part [36] is expressed as [T(A)]>[T(B)]>[T(C)].

[0027] From the in-side end of the in-side cylindrical part [36], there is the formation of a flange [38] which is extended toward the /4
outer side in terms of the diameter direction and which has a front end that is bent toward the in side, and the flange [38] faces the flange

[26]. This flange [38] prevents the tire (not shown) attached to the disc wheel [10] from being displaced toward the in side and strengthens the rim part [14].

[0028] Moreover, the disc wheel [10], in its entirely, is integrally formed from an expandable material, such as aluminum.

[0029] Next, the method for manufacturing a disc wheel [10] related to the embodiment will be described. First, a circular plate formed from an expandable material (e.g., aluminum) having the same thickness as the disc part [12] is prepared. This circular plate is made to have a predetermined diameter by taking into account the diameter of the disc part [12] and the axial length of the rim part [14].

[0030] This circular plate is pressed to form a disc part [12] (see Fig. 1) first. In other words, the circular plate is pressed from both axial sides (in side and out side) by means of molds to form an inner circle part [16], tapered part [18], and outer ring part [20]. At this time, hub holes [22] and bolt holes [24] are also created. The thicknesses of the respective parts of the disc part [12] can be made different from one another by partially changing the pressure applied during the press working.

[0031] Moreover, the part of the expandable material, which makes up the circular plate, at the outer side of the outer ring part [20] is bent toward the in side to form a rim-to-be cylindrical part [40] to achieve the overall shape of a cylinder with a bottom as shown in Fig. 3. Moreover, the portion of the disc part [12] and the portion of the rim part [40] can be simultaneously and directly formed from a flat circular plate into

a cylinder with a bottom shown in Figure 3 by means of press working.

[0032] Since the rim-to-be part [40] is formed by bending a circular plate having a constant thickness, the thickness of the rim-to-be part [40] is constant and is approximately the same as the thickness of the disc part [12]. This rim-to-be part [40] is formed into a rim part [14] (see Figs. 1 and 2) in a later process. Moreover, a flange-to-be part [42] which stretches toward the outer side in the diameter direction is formed in advance at the in-side end of the rim-to-be part [40]. This flange-to-be part [42] is formed into a flange [38] (see Figs. 1 and 2) in a later process.

[0033] Next, as shown in Fig. 4, part of the rim-to-be part [40] is reduced in diameter and thickness by means of spinning to form the rim part [14].

[0034] In other words, a mandrel [44] is inserted into the inner face of the rim-to-be part [40] from the in side. The top surface [45] of this mandrel [44] has a shape that matches the inner circle part [16] and tapered part [18] of the disc part [12] and contacts the surfaces of the inner circle part [16] and tapered part [18]. The periphery of the mandrel [44] comprises a reduced-diameter-part-matching face [46] which corresponds to the reduced diameter part [32] of the rim part [14], a tapered-part-matching face [48] which corresponds to the tapered part [34], an in-side-cylinder-part-matching face [50] which corresponds to the in-side cylinder part [36], and a flange-matching face [52] which corresponds to the flange [38].

[0035] Next, the mandrel [44] is rotated about the central axis [J1]

of the disc part [12], and the disc part [12] and rim-to-be part [40] are rotated together with the mandrel [44]. Then, a forming roller [54] is moved from the outer side of the rotating rim-to-be part [40] to the in side (the direction indicated by the arrow [A]) while pressed against it.

[0036] The forming roller [54] has the shape of an approximate circular plate that becomes gradually thinner from the center to the outer periphery. Moreover, the central axis [J2] is parallel to the central axis [J1] of the disc part [12]. The outer rim of the forming roller [54] is rounded, and its lateral view forms a smooth curve. The forming roller [54] can move at a constant or predetermined speed in the same direction as the central axis [J2] and can approach or move away from the central axis [J1] of the disc part [12].

[0037] The forming roller [54] is first pressed against the out-side end of the rim-to-be part [40] as shown in Fig. 4. It is then moved toward the in side (in the direction [A] indicated by the arrow), is made to quickly approach the central axis [J1], and presses the rim-to-be part [40] from the outer side toward the central axis [J1]. As a result, the out-side end of the rim-to-be part [40] becomes bent, and a flange [26] which makes up the rim part [14] is formed. Next, the forming roller [54] is made to move toward the in side while very gradually approaching the central axis [J1] and thus presses the rim-to-be part [40] from the outer side toward the central axis [C]. As a result, the out-side cylinder part [28] is formed. When the forming roller [54] reaches the position indicated by reference numeral [54A] in Figure 4, it quickly approaches the central

axis [J1] again. Thus, the rim-to-be part [40] is pressed from the outer side toward the central axis [C] to form a step part [30]. By this, the inner surface of the step part [30] contacts the reduced-diameter-part-matching face [46] of the mandrel [44].

[0038] Furthermore, the forming roller [54] is moved to the in side while keeping a constant interval between the mandrel [44] and the reduced-diameter-part-matching face [46] as indicated by reference numeral [54B] to form a reduced-diameter part [32] having a predetermined thickness [T(A)]. After the outer rim of the mandrel [44] reached the in-side end of the reduced-diameter part [32], the forming roller [54] is made to move toward the in side while gradually moving away from the central axis [J1] as indicated by reference numeral [54C] to form a tapered part [34]. At this time, the position of the forming roller [54] is adjusted so that the interval between the tapered-part-matching face [48] of the mandrel [44] and the forming roller [54] will gradually decrease, and the interval between the forming roller [54] and the tapered-part-matching face [48] will be the same as the thickness [T(C)] when the forming roller reaches the in-side end of the tapered part [34]. As a result, the tapered part [34] becomes gradually thinner toward the in side. In particular, the thickness of the tapered part [34] at its axial center will be [T(B)].

[0039] When the forming roller [54] reaches the in-side end of the tapered part [34], the forming roller [54] is moved toward the in side as indicated by reference numeral [54D] while maintaining a constant interval from the in-side-cylinder-part-matching face [50] of the /5
mandrel [44]. Thus, the in-side cylinder part [36] having the thickness

of [T(C)] is formed.

[0040] When the forming roller [54] reaches the in-side end of the in-side cylinder part [36], the forming roller [54] is quickly moved away from the central axis [J1] while moving to the in side. Then, the forming roller [54] is moved to the in side while a predetermined interval is maintained between the forming roller [54] and the flange-matching face [52] of the mandrel [44] to form a flange [38]. Through these processes, the diameter of the rim-to-be part [40], except for its axial ends, is reduced by the pressures applied to the outer periphery to form a rim part [14].

[0041] In this manner, according to the method of the embodiment for manufacturing a disc wheel [10], a circular plate having the same thickness as the disc part [12] is pressed to form the disc part [12] and the rim-to-be part [40]. Therefore, the necessary forming pressure can be reduced (A press-working machine capable of handling 2000 tons will suffice.) compared to the conventional case in which a workpiece (billet) is sandwiched between an upper mold and a lower mold to form the disc part and rim-to-be part (This requires casting equipment capable of handling at least 5000 tons).

[0042] Since the thickness of the rim-to-be part [40] is approximately the same as the thickness of the pre-pressed expandable material, that is to say the thickness of the disc part [12], the disc part [12] can be made thin and the disc wheel [10] can be reduced in weight as a result in comparison to the conventional case in which the rim part is formed by the disc being cut open.

[0043] Moreover, by allowing the forming roller [54] to approach and move away from the central axis [J1] while moving toward the in side at a constant speed, it will be possible to easily form a rim part [14] that comprises a reduced-diameter part [32] in which the diameter is partially reduced, a step part [30] which continues from the reduced-diameter part [32], and a tapered part [34], thereby forming the rim part [14] having various diameters. It is even possible to make the rim part [14] partially thin by adjusting the interval between the outer periphery of the mandrel [44] and the forming roller [54]. As mentioned earlier, when the rim part [14] is formed in a manner such that the relationship among the thickness [T(A)] of the reduced-diameter part [32], the thickness [T(B)] of the axial center of the tapered part [34], and the thickness [T(C)] of the in-side cylinder part [36] will be expressed by [T(A)]>[T(B)]>[T(C)], the in-side cylinder part [36] becomes thin and the overall weight of the disc wheel [10] can be reduced. Conversely, the rim part [14] can be formed in a manner such that [T(A)]<[T(B)]<[T(C)] will be true, in which case the in-side cylinder part [36] which directly receives the effect of the load from a tire (not shown) will be thicker than the reduced-diameter part [32], and the strength of the disc wheel [10] can be increased. The above-mentioned size relationships among the thicknesses, [T(A)], [T(B)], and [T(C)], are merely examples, and the rim part [14] can be formed in various other thicknesses instead. For example, in the relationship, [T(A)]≥[T(B)]≥[T(C)] or [T(A)]≤[T(B)]≤[T(C)], [T(A)] and [T(B)] can be made equal or [T(B)] and [T(C)] can be made equal. It is even possible to make all of [T(A)], [T(B)],

and [T(C)] equal. The shapes of the disc part [12] and rim part [14] can be any desired shapes instead of those mentioned earlier.

[0044] Since the rim-to-be part [40] has a constant thickness before it is formed into a rim part [14], it is easy to form the rim part [14] by using a forming roller [54].

[0045] Moreover, according to the method of the embodiment for manufacturing a disc wheel [10], a disc wheel [10] in which the disc part [12] and the rim part [14] are integrated with each other can be formed from an expandable material, such as aluminum. Therefore, the process for welding and the like, which is necessary for forming a disc wheel from multiple parts, becomes unnecessary, and the productivity increases as a result.

[0046] During the spinning process, a different pressing member, such as a spatula, can be used instead of the above-mentioned forming roller [54]. When a forming roller [54] is used, the forming roller [54] rotates about its central axis [J2]. Therefore, the frictional force that occurs as a result of the rim-to-be part [40] being contacted is smaller than a case in which a spatula is used instead.

[0047] [Effects of the Invention]

According to the invention of Claim 1, a plate-shaped expandable material is pressed into a cylinder with a bottom, and the cylinder part of the expandable material which was formed into the cylinder with a bottom in the above process is made to have different diameters in the axial direction by means of spinning. Therefore, a light-weight disc wheel can be formed with ease.

[0048] The invention according to Claim 2 is a disc wheel formed from an integrated expandable material and comprises: a disc-shaped disc part; and a rim part in which one axial end is integrally continuous to the outer rim of the disc part and which has a cylindrical shape that decreases in diameter because of pressures applied to the outer periphery except for its axial ends. Therefore, a light-weight high-strength disc wheel can be obtained.

[Brief Description of the Drawings]

[Figure 1] A cross-sectional drawing of a disc wheel of one embodiment of the invention.

[Figure 2] A magnified cross-sectional drawing of a disc wheel of one embodiment of the invention.

[Figure 3] A cross-sectional drawing of a disc wheel being manufactured by the disc wheel manufacturing method of one embodiment of the invention.

[Figure 5] A drawing for explaining the manufacturing method of a conventional disc wheel.

[Figure 6] A drawing for explaining the manufacturing method of a conventional disc wheel.

[Explanation of Reference Numerals]

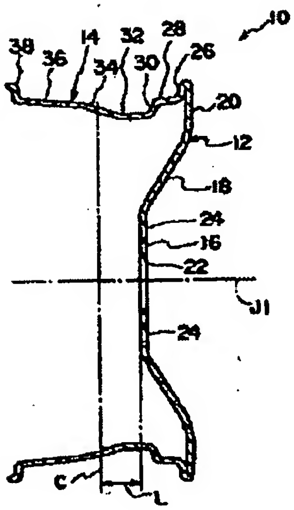
[10] = disc wheel

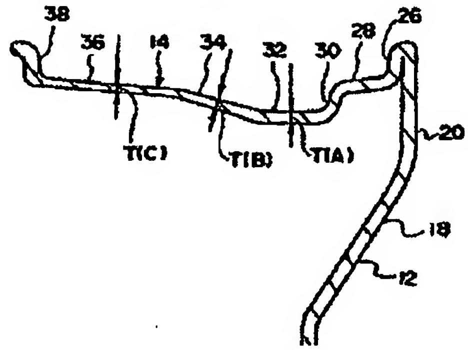
[12] = disc part

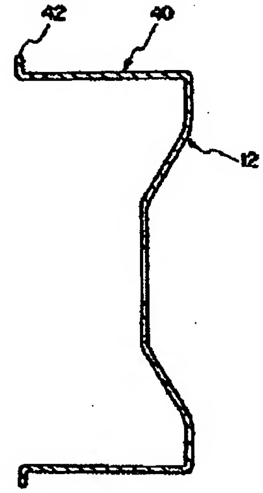
[14] = rim part

[40] = rim-to-be part (cylinder part)

[Figure 1] [Figure 2] [Figure 3] /6



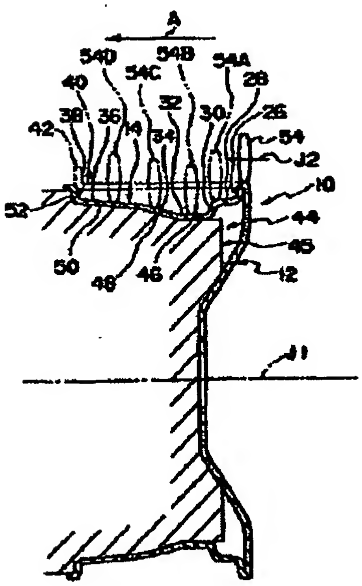




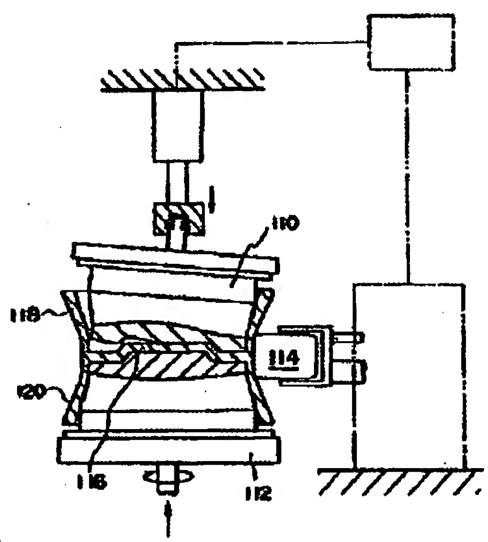
Key: 10) disc wheel; 12) disc part; 14) rim part.

Key: 40) rim-to-be part (cylinder part).

[Figure 4]



[Figure 5]



[Figure 6]